Quick Installation
From Install NS2 (Network Simulator) on Ubuntu 18.04 | Blog

Possible Warnings
ns found the right version of tclsh in /usr/bin/tclsh8.6 but it doesn't seem to be there anymore for ns2
> sudo apt install tclsh

Documentation
The Network Simulator ns-2: Documentation
The ns Manual (formerly ns Notes and Documentation)1 (pdf)

Tutorials
Marc Greis' Tutorial for the UCB/LBNL/VINT Network Simulator "ns"

NS2 Simulation

Write in TCL language (Tutorial: Tcl/Tk Tutorial and/or Google)

Write a .tcl file that contains

- Topology (how many nodes, how they are placed)
- Node(Router) configs (routing protocol, energy consumption)
- Flow configs (what is source and destination)
- Flow generator configs (how many bits/sec, packet size)
- Link configs (between which nodes, bandwidth, delay, queue size, queue type)

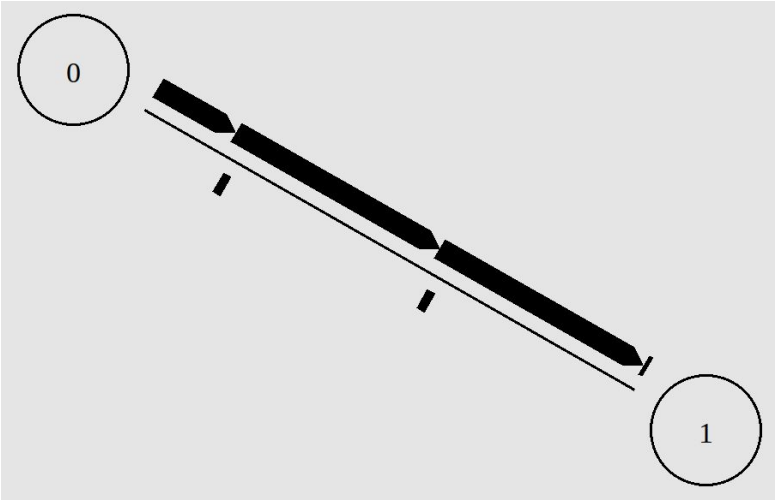
Flow/Traffic: [src_ip, src_port] -> [dest_ip, dest_port]

Events

- When to start/stop flow
- When to start/stop a router
- When to down a link
- When to end simulation

Wired Connection 1-1

Topology



- Node creation
- Establish wired Link
- Agent (Transport Layer) Creation
- Attach agent to node
- Application Creation
- Attach agent to application

Agent:

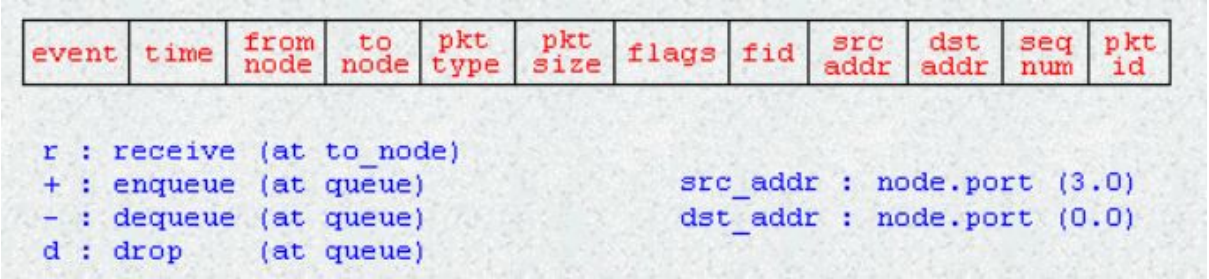
```
$ns attach-agent <node> <agent>
```

This is a common command used to attach any <agent> to a given <node>.

```
$traffic-gen attach-agent <agent>
```

This a class Application/Traffic/<traffic type> method which connects the traffic generator to the given <agent>. For example, if we want to setup a CBR traffic flow for the udp agent, udp1, we given the following commands

Trace file meaning:




```
+ 1 0 1 tcp 40 ------- 1 0.0 1.0 0 0
- 1 0 1 tcp 40 ------- 1 0.0 1.0 0 0
r 1.01016 0 1 tcp 40 ------- 1 0.0 1.0 0 0
+ 1.01016 1 0 ack 40 ------- 1 1.0 0.0 0 1
- 1.01016 1 0 ack 40 ------- 1 1.0 0.0 0 1
r 1.02032 1 0 ack 40 ------- 1 1.0 0.0 0 1
+ 1.02032 0 1 tcp 1040 ------- 1 0.0 1.0 1 2
```

Event	Abbreviation	Type	Value
Normal Event	r: Receive d: Drop e: Error +: Enqueue -: Dequeue	`%g %d %d %s %d %s %d %d.%d %d.%d %d %d`	
		double	Time
		int	(Link-layer) Source Node
		int	(Link-layer) Destination Node
		string	Packet Type
		int	Packet Size in bytes
		string	Flags
		int	Flow ID
		int.int	(Network-layer) Source Address
			Source Port
		int.int	(Network-layer) Destination Address
			Destination Port
		int	Sequence Number
		int	Unique Packet ID

Analysis:

- Network throughput (number of data bits delivered / sec)
- End-to-end average delay
- Packet delivery ratio (total # of packets delivered to end destination / total # of packets sent)
- Packet drop ratio (total # of packets dropped / total # of packets sent)

Example: wired.tcl, example3.tcl

Wireless 1-1

Node Configs

```
$ns node-config -addressingType flat or hierarchical or expanded
                -adhocRouting   DSDV or DSR or TORA or AODV
                -llType         LL
                -macType        Mac/802_11
                -propType       "Propagation/TwoRayGround"
                -ifqType        "Queue/DropTail/PriQueue"
                -ifqLen         50
                -phyType        "Phy/WirelessPhy"
                -antType        "Antenna/OmniAntenna"
                -channelType    "Channel/WirelessChannel"
                -topoInstance   $topo
                -energyModel    "EnergyModel"
                -initialEnergy  (in Joules)
                -rxPower        (in W)
                -txPower        (in W)
                -agentTrace     ON or OFF
                -routerTrace    ON or OFF
                -macTrace       ON or OFF
                -movementTrace  ON or OFF
```

Trace file

event	time	_node_	layer		packet_id	packet_type	packet_bytes		
s,r,D			RTR AGT			tcp,ack,cbr			

```
r 23.017060294 _15_ AGT  --- 887 tcp 1060 [13a f 9 800] ------- [5:0 15:0 31 15] [228 0] 2
0
s 23.017060294 _15_ AGT  --- 924 ack 40 [0 0 0 0] ------- [15:0 5:0 32 0] [228 0] 0 0
r 23.017060294 _15_ RTR  --- 924 ack 40 [0 0 0 0] ------- [15:0 5:0 32 0] [228 0] 0 0
s 23.017060294 _15_ RTR  --- 924 ack 60 [0 0 0 0] ------- [15:0 5:0 32 9] [228 0] 0 0
r 23.027347122 _15_ RTR  --- 890 tcp 1060 [13a f 9 800] ------- [9:0 19:0 32 15] [113 0] 1
0
f 23.027347122 _15_ RTR  --- 890 tcp 1060 [13a f 9 800] ------- [9:0 19:0 31 19] [113 0] 1
0
r 23.029413243 _9_ RTR  --- 920 ack 60 [13a 9 f 800] ------- [15:0 5:0 32 9] [226 0] 1 0
f 23.029413243 _9_ RTR  --- 920 ack 60 [13a 9 f 800] ------- [15:0 5:0 31 5] [226 0] 1 0
```

Analysis:

- Network throughput (number of data bits delivered / sec)
- End-to-end average delay

- Packet delivery ratio (total # of packets delivered to end destination / total # of packets sent)
- Packet drop ratio (total # of packets dropped / total # of packets sent)
- Energy consumption [for wireless nodes]

Home Task

- Wireless simulation
- Mobile nodes
- Generate trace
- Calculate metrics
- Energy modeling
- Calculate energy consumption